

Eos, Transactions, American Geophysical Union

Vol. 65, No. 43, Pages 769-784

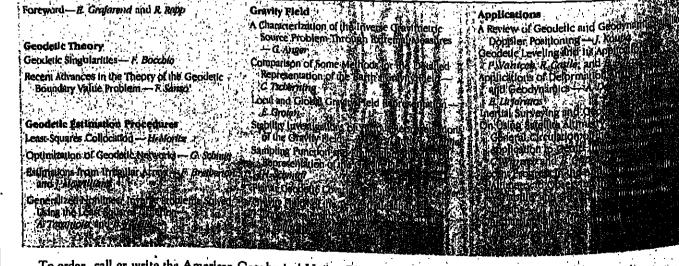
October 23, 1984

Advances in Geodesy Edited by Erik W. Grafarend and Richard H. Rapp \$23

From papers previously published in AGU's prestigious journal, *Reviews of Geophysics and Space Physics*, this volume is a collection of 30 papers which are sharply focused on recent advances in solving geodetic problems. The papers are divided into four sections: Geodetic Theory, Geodetic Estimation Procedures, Gravity Field, and Applications.

ADVANCES IN GEODESY, a thoughtful examination of recent geodetic developments, is required reading for those with either central or peripheral interests in geodesy.

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Uranium in the Earth's Core

Roy C. Feber and Terry C. Wallace Los Alamos Scientific Laboratory Los Alamos, NM 87545

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That there is no radioactivity in the earth's core is a concept that has long been held. The reason is that the major radioactive elements, potassium and uranium, exist as siderophobic compounds, such as silicates and oxides, in the earth's mantle and thus were thought to be immiscible with the metal core. An experimental measurement of the binary system of steel and UO₂, however, shows that above 3120 K the system is a two-phase liquid, the one rich in UO₂ and the other poor in UO₂. The phase diagram predicts that there must be a temperature above which there is total miscibility between UO₂ and steel. This temperature may be above the boiling point of UO₂, estimated as 3750 K. The temperature at the core-mantle interface of the earth's interior is estimated most recently as 3130 K. Thus there is a strong likelihood that uranium exists in the earth's metal core. Hence the natural alpha radioactivity of uranium offers a power source for the earth's magnetic dynamo.

Introduction

A heat source of 5 × 10¹⁶ erg/s in the earth's core is estimated to be more than sufficient to sustain convection and thus to maintain the earth's magnetic field [Jacobs, 1975, p. 267]. The prossible heat sources, radioactive potassium and radioactive actinides, are expected to exist, however, mainly as siderophobic compounds, such as oxides and silicates, which are immiscible in the earth's metal core [Urry, 1952, p. 92].

Considerable discussion has appeared in the literature about the possibility of potassium having been incorporated into the metal core, for example, in the primitive differentiating earth. Less attention has been given to the possibility of uranium existing in the core [see Jacobs, 1975, pp. 201–208; Somerable and Ahrens, 1980; Ahrens, 1982]. In fact, uranium appears to be steadily incorporated into the metal core at all times, not only in the primitive differentiating earth but at the presentime as well. The evidence is experimental.

Except for hypothetical incorporation of potassium into the core in the primitive differentiating earth, the other heat source suggested has been the continuous growth of the iron core of the earth from migration of iron in the mantle and the corresponding release of gravitational energy. The experiment of Hodkin and Potter [1980] now makes it likely that uranium is steadily dissolving into the core and supplying radioactive heat.

The Experiment

The experiment was performed by Hodkin and Patter [1980] as follows. Stainless steel and UO2 were melted together by an are discharge between a tungsten cathode and an anode crocible until observation of the melt was obscured by expor of the uranium oxides at temperatures more than 3120 K. After melting had proceded for 7 minutes, the crucible was cooled. This cooling produced an ingot which was examined by electron probe microanalysis. In the molien state, two intuits

cible liquids had been present. One was UO₂ with 1% weight of steel, and the other was steel with 23% weight of UO₂. The experimenters conclude that there is a temperature above which there is total miscibility between UO₂ and steel; however, that temperature may be above the boiling point of UO₂, estimated as 3750 K.

The projected phase diagram for UO2-steel is shown in Figure 1, where the temperature in degrees Kelvin is plotted versus weight percent. The experimentally measured points lie on the uppermost solid line at 99% and 23% weight of UO2, respectively, at a temperature somewhat higher than 3120 K.

One may inquire whether the presence of

One may inquire whether the presence of 2% Mn, 10% Ni, and 16% Cr in the steel may substantially affect the two-phase nature of the liquid-liquid region of the phase diagram. The answer appears to be no, judging from other experiments made by *Holkin and Polter* [1980]. In one of these, they melted stainless steel, UO2, Mo, Ru, Rh, and Pd. The condensate contained 41% weight UO2. Even at temperatures that were probably line above the melting point of manium, there was 26% weight of UO2 dissolved in liquid stainless steel.

Hodhin and Potter [1980] also present a possible U-G-O phase diagram for 2550 K which shows that uranium can be reduced by carbon (which presumably can be present in the earth's core as it is present in iron and steel) to a region of two liquids, the one being rich in U and the other being rich in $UO_{2,x}$. If this occurs, then there is a good probability that the U-rich liquid will mix with the liquid iron at all values of weight percent (see phase diagram of Fe versus U by Hultgren et

al.[1971, p. 895]).

What might be the effect of high pressure on the UOx-steet phase diagram? The review and analysis of Anderson [1982] attempts to answer this question in the form of the effect of pressure on the temperature at the coremantle interface of the earth. The answer appears to be that the phase boundaries in Figure 1 may be shifted up by pressure but

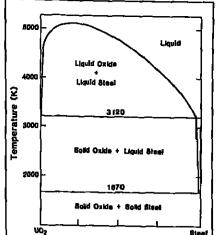


Fig. 1 Phase diagram for UO2 and seel. The two immiscible liquids in the liquid-liquid region were measured at a temperature somewhat above 3120 K.

down by chemical effects of small amounts of other substances. Anderson balances these perturbations against each other to arrive at 3131 K as the temperature of the core-mantle boundary.

Uranium Radioactivity in the Earth's Core

The experimental demonstration of two liquids coexisting in the liquid system of UO2 and steel at temperatures \$120 K up to perhaps 5000 K and total miscibility above that leads us to consider that there is probably continuous absorption of uranium from the mande into the earth's metal core. Radioactive decay of uranium in the earth's core offers a power source for the dynamo that creates and maintains the earth's magnetic field.

After 4.6 b.y. of existence of the solar system, the energy in the decay chain of uranium is mostly that from \$2.00 and amounts to 32.9 MeV per arom. The volume of the core is 1.77 × 10²³ cm³ at a density of 14.6 gm/cm³ [Anderson, 1982] and contains 2.58 × 10²⁴ gm of iron. At the cosmic abundance of uranium it also contains 1.45 × 10¹⁸ gm U, which provides an alpha particle heat source of 2.7 × 10¹⁷ erg/s in the core. According to facols [1975, p. 267], the olumic dissipation of currents in the core which maintain the geomagnetic held are of the order of 5 × 10¹⁶ erg/s. Thus the heat from uranium in the core at its natural abundance appears to be sufficient to power the dynamo, assuming an efficiency of about one tenth.

Additional trianium may enter the core (as a component of the two-liquid system) from the lower mantle. This addition is suggested by an analysis of Schubert and Spohn [1981], who find that the lower mantle is depleted in radioactivity and can contain only 8% or less of all the hear-producing radioactive elements in the mantle. Other estimates of the fraction of the mantle that has been depleted range from ¼ to ½ (see references of Schubert and Spohn, [1981]).

Conclusion

Experiments on the phase diagram of UO₂-stainless steel, made for breeder research, show that at temperatures equal to that of the core-mantle interface of the earth a binary liquid system exists, containing two liquids, the one rich in UO₂ and the other poor in UO₂. The experiments also show that adul-

teration of the system with elements intermediate in the periodic table have little effect on the phase diagram. The effect of pressure has been studied by others and thought to be small. Therefore we infer that uranium may well exist in the earth's core in significant quantities and at a natural abundance that is sufficient to maintain the earth's magnetic field. It may also be continuously extracted from the lower mantle, adding to the uranium component of the core.

The phase diagram of UO-iron should be studied more thoroughly. Thorium oxide-uranium may behave similarly. The decay time of thorium is about three times longer, but its abundance is six times greater. Its phase diagram should be studied also.

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Terry C. Wallace, Sr., is the Associate Division Leader for Energy Technologies, Materials Sowner and Technology Division, Los Alamos National Loboratory. His interests include high-temperature chemistry research, development of new materials for utilization in adverse environments and development of the second servicians.

tion in accesse environments, and development of materials science and technology capabilities needed for lunar bases and space activities in the 21st century.

Leona Marshall Libby is consultant at Los Alamo Scientific Laboratory and adjunct professor of engineering at University of California at Los Angeles.



News

1984 Solar Eclipse

At a recent meeting of the incoherent scatter radar user community an experiment was planned to observe the ionospheric and thermospheric response to the May 30, 1984, annular solar eclipse with the meridional radar chain whose elements span the eclipse path. Investigators from the National Center for Atmospheric Research (NCAR), the Air Force Geophysics Laboratory, SR1 International, Arecibo Observatory, and the Massachusetts Institute of Technology (MIT) Haystack Observatory were involved in this experiment. The operation of the incoherent scatter radars is sponsored by the National Science Foundation Atmospheric Sciences Division.

Three radars participated in the observations of the eclipse effects: Arecibo (18°N),
Millstone Hill (48°N), and Sondrestrom
(67°N). The Millstone Hill radar was within
3° latitude of the path of the eclipse and experienced a maximum solar obscuration of
92% at 1705 UT. The eclipse duration was
approximately 3 hours. Measurements at
Millstone Hill included electron density, plasma temperatures, and ion drifts overhead iseing the 67-m zenith antenna and to the south
and southwest at low elevations (10+15°) us

ing the 46-m steerable antenna to map drift velocity vectors and extend the observations towards the Arecibo station. Millstone Hill began gathering observations at 1200 UT and continued through the eclipse to 2200 UT. The automated data processing and graphics capabilities at Millstone Hill were utilized to obtain initial results of the eclipse observations within 12 hours of the completion of the experiment, and the data were placed in the remotely accessible user data base on the Millstone computer. These data are available to the research community on request.

The color photograph on the cover of this issue illustrates the results obtained from Millstone Hill with the steerable antenna directed to the southwest. This beam intersected the eclipse center line 5° west of the Millstone Hill meridian at 300 km altitude, where maximum obscuration occurred at 1641 UT. The frames show (top to bottom) color-coded intensity contours of the electron density, ion temperature, electron temperature, and ion drift line-of-sight velocity as a function of alti-tude up to 600 km and universal time from 14 to 20 hours. The electron temperature decreased by 750 K at 300 km centered on the eclipse time, while the electron density minimum was 70% of the preeclipse value at that altitude and occurred 30 minutes later. There was a much smaller effect on the ion temperature. The plasma drift velocity developed

a northward component of \sim 75 m/s as the eclipse effects began. This latter effect may be a result of some geomagnetic activity (Kp = 0)

The ionospheric data collected at Millstone Hill as well as that from the other radars will be analyzed in detail, and thermospheric purameters such as the exospheric temperature and the meridional neutral wind companent will be derived from the measurements. These, in turn, will be compared to predictions already made at NCAR for the eclipse using the Thermospheric General Circulation Model. In a preliminary review it was seen that the model predictions are generally consistent with the observed drop in electron density and electron temperatures. Detailed quantitative comparisons require further study.

This news item was submitted by Joseph E. Sa-Jali, Director, MIT Haystack Observatory.

Land and Seabed Deformation

The development of techniques to monitor underses and ground surface deformation and sea level changes will be highlighted at a session of invited geodesy papers at the AGU

Fall Meeting, to be held in San Francisco, Calif., December 8-7, 1984.

The oceans conceal the earth's largest sudden deformation events. Subduction earthquakes at great plate boundaries produce 10—20-m motions of the crust near olfshore trenches. Inflation of undersea volcances and the spreading of midocean rifts also produce large changes that may go unnoticed. The great tsunami-generating earthquakes may be associated with unusually large vertical movements of the seabed; these earthquakes also may cause vast undersea landslides. Technologies to predict these large movements have potential for improving earthquake prediction, tsunami warning, and prediction of volcanic eruptions. Fred Speiss, chief editor of a recent National Academy of Sciences book on undersea deformation, will chair this session.

Presentations at another geodesy session will detail efforts to monitor and record the ground surface deformation that precedes earthquakes. Measurement of deformation remains a vital and elusive goal of earth scientists. By understanding these processes, geologists hope to learn more about predicting when and where large quakes will occur. The best results achieved to date in several different projects will be presented at the session, along with the strategy and expectations for

News (cont. on p. 786)

at Parkfield before 1990. The last two Parkfield quakes, in 1934 and 1966, were each preceded by a magnitude 5 foreshock located 1.6 km from the main shock; each occurred 17 minutes before the main shock. According to geologists involved, this makes Parkfield a "uniquely well-behaved" site for deploying networks of high precision to monitor ground deformation and precursory seismicity.

Such a network is largely in place. The instruments that make up this network include some 30 high-gain seismometers. Data from these instruments are telemetered back to the USGS at Menlo Park, Calif., and in some cases are computer-analyzed in real time. About 50 strong motion instruments also have been deployed to give seismologists a reading on

The geodetic network at Parkfield makes use of the large-scale geodimeter network used throughout California as well as a twocolor laser geodimeter to measure movement along either side of the fault. The laser geodimeter records information from a dozen baselines from 4 to 8 km in length. Other instruments deployed include downhole strain measurement devices and low-sensitivity creep meters. -DWR

Tropospheric Chemistry Research

To unswer basic science questions about man's influence on the earth's troposphere and how to protect it, a National Research Council (NRC) panel has proposed a longterm international research program to study global tropospheric chemistry. The panel esti-mates that initial funding of \$10-\$20 million per year will be required, increasing yearly for the program's minimum 10-year life.

According to the panel, this proposed effort would be different from existing atmospheric chemistry programs, such as those concerning acid precipitation, for two reasons: First, the proposal calls for a long-term effort, not a short-term reaction to political pressures or, as noted by one member of the panel, "crisis response." Second, the panel emphasized the global framework and international cooperation requested in the proposal. According to panel members, many existing studies are urban or regional in nature and do not have the scope required to gain an overall understanding of the complex troposphere. Existing programs are seen as a foundation for what is envisioned as an all-

encompassing program.

Robert A. Duce, chairman of NRC's Global Tropospheric Chemistry Panel and professor at the University of Rhode Island, speaking at a briefing on October 17, in Washington D.C., summarized the overall objectives of the project: To find out how and to what degree the biosphere controls earth's climate and to determine over what time periods this takes

Long-term objectives of the program are:
"1. To understand the basic chemical cycles in the troposphere through field investigations, theory aided by numerical modeling, and laboratory studies.

"2. To predict tropospheric responses to perturbations, both natural and human-induced, of these cycles.

"3. To provide information required for the maintenance and effective future management of the atmospheric component of the global life support system.

Specific science objectives of the proposed study include evaluation of biological sources of chemicals in the troposphere, determina-tion of the global distribution of trace gases and acrosol particles, investigation of photochemically driven transformation processes as well as wet and dry removal processes for trace gases and aerosol particles, and the development of global tropospheric chemistry systems models.

In its report, called "Global Atmospheric Chemistry, A Plan for Action," the panel suggested that funding of individual investigations and investigators could be handled through already established National Science Foundation (NSF) and National Aeronautics and Space Administration (NASA) channels but indicated only that overall science management of such a program should be assigned to "an appropriate U.S. scientific organization." Other organizations expected to be involved include the National Oceanic and Atmospheric Administration (NOAA), the Department of Energy (DOE), the Environmental Protection Agency (EPA), and the Department of Defense (DOD), as well as universities, private research groups, and industry

Members of the panel indicated that a future workshop, to be attended by 50-80 members of the U.S. and international atmospheric chemistry community, will be held to begin pinpointing specific research needs within the framework of the proposal. A steering committee is now in the process of organizing this meeting.—DWR

Atlantic Hot Vent **Discoveries**

By using the chemical concentration of water as a key to location, scientists from the National Oceanographic and Atmospheric Administration (NOAA) and several U.S. universities have identified three new Atlantic Ocean sites of mineral-rich hot vents. This discovery brings the total number of known Atlantic Ocean vent sites to four.

These Atlantic Ocean discoveries lead scientists to speculate that venting sites may be as prevalent in the Atlantic as they are in the Pacific. According to Peter Rona of NOAA's Atlantic Oceanographic and Meteorological Laboratory in Miami, Fla., hot seabed vents were thought to occur primarily at last spreading undersea ridges, such as those that exist in the Pacific Ocean, but not at the relatively slow spreading ridges, such as those found in the Atlantic

In 1982 a venting area was discovered in the Atlantic along the mid-Atlantic ridge about 2,800 km east of Miami. Large deposits of manganese were associated with the site. The latest discoveries are located along the ridge, 800-1,600 km south of the original

In related news, scientists at the Scripps Institute of Oceanography have reported the discovery of biological communities in the Gulf of Mexico similar to those found in the Pacific hot vent areas.

According to Charles Paull, a member of the Scripps Geologic Research Division who took part in the research cruise last February when the discovery was made, the Gulf of Mexico communities are similar in their biology but exist within an entirely different geological setting. Chief among the differences is a lack of the high temperatures that have been associated with the Pacific vent sites. Instead, scientists involved believe that the minerals needed to sustain the communities may be supplied from the Florida escarpment. Paull will present his findings at the AGU Fall Meeting, to be held in San Francisco, Calif., December 3-7, 1984.

Geophysicists

Carroll Ann Hodges has been appointed assistant chief geologist for the U.S. Geological Survey's Western Region, headquartered in Menlo Park, Calif. She succeeds G. Brent Dalrymple, who has returned to research studies in isotope geology at Western Region head-quarters after serving as assistant chief geolo-gist for 3 years. Hodges joined the USGS Branch of Astrogeological Studies in Menlo Park in 1970. Her research has consisted mainly of topical studies and mapping projects on the moon and Mars. She was princil investigator in Apollo 16 geologic analyses both before and after that lunar mission. Since 1982 she has served with the survey's Branch of Western Mineral Resources as chief of an international minerals resource assessment project. In 1980-1981, Hodges was the AGU Congressional Science Fellow on Capitol Hill. She is a member of the AGU Public Affairs Committee.

Rafael N. Sauchez has been appointed visiting professor with the University of Buenos Aires and was accepted as a member-correspondent of the Academia Nacional de Inieria, Argentina. Sanchez, a professor of Laval University, is currently on sabbatical.

Charles J. Daly, 34, died September 20. 1984. A member of the Hydrology Section.

he joined AGU in 1979. Paul A. Duich, 68, a member of the Atmospheric Sciences Section, died recently. He iolned AGU in 1963.

Hiroyuki Fukuyama, 36, died in August 1984. A member of the Volcanology, Geo-chemistry, and Petrology Section, he joined

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Precambrian Sulphide Deposits

R. W. Hutchinson, C. D. Spence, and J. M. Franklin (Eds.), H. S. Robinson Memorial Volume, Geol. Assoc. of Can. Spec. Pap. 25, Geological Association of Canada, Toronto, Ontario. vii + 792 pp., 1982, \$57.00.

Reviewed by Bruce R. Doe

This book is dedicated to Howard S. Robinson, who was born and educated in the United States, but who spent his professiona career in Canada with McIntyre Porcupine Mines, concentrating on Precambrian mineral deposits. Although his career in mineral exploration was distinguished, his major contri-bution to earth science was probably as one of the founders of the Geological Association of Canada, an institution to which he made a bequest in his will. With this background, the strong emphasis on Canadian Precambrian mineral deposits should come as no surprise; of the 23 papers in this book, 21 are solely or primarily devoted to Canadian deposits. The wo exceptions—those describing the Balmat, N. Y., zinc mines (at times the largest zinc producer in the United States) and the Crandon, Wisconsin, volcanogenic zinc-copper massive-sulfide deposit (the largest deposit o its kind found in the 1970's)—are each within a couple of hundred kilometers of the Canadian border. Although the title of the book is more expansive than the actual topics dis-cussed, Canada is rich in Precambrian rocks and ore bodies, and Canadian scientists have been especially alert to tectonic influences in the formation of mineral deposits. These features, plus the fact that the country contains a very well exposed expanse of Archean rocks which is the largest in the world, facilitate the study of early crustal evolution and make the book of particular interest to geo-

The book comprises two parts. Part I, which may be of greatest interest to geophysicists, is composed of four regional papers: one on the Superior, Slave and Churchill provinces by J. M. Franklin and R. I. Thorne. a second on the Grenville province by A. L. Sangster and J. Bourne, a third on the Purcell Supergroup by T. Hoy (the Canadian equivalent of the Belt Supergroup in Cana-da), and the fourth on the Mackenzie fold belt by J. D. Aitken. Much information is included in these chapters that is not specificaly related to ore deposits. For just two examples, there is a map of the greenstone and gneiss belts of Canada and another showing ow the Grenville fits into a paleotectonic reconstruction with the Oaxaca metamorphic complex and Sveconorweigian province. A fi-nal paper by R. W. Hutchinson (one of the world's leading experts in metallogenesis) summarizes the whole book and brings some sense of common theme to both the regional papers and part II on case histories, i.e., the portance of heated submarine exhalations as a function of tectonic setting for the genesis of most Precambrian ores. The recognition of the importance of submarine exhalations in ore deposition began in Europe with Schneiderhön in 1932, received support from Oftedahl in the late 1950's, became firmly adopted in Japan in the 1960's, was introduced in Canada by the Australian R. L. Stanton in the late 1950's, and only achieved some degree of acceptance in the United States by the mid-1960's owing to writings of Charles A. Anderson after his visits to the Miocene Kuroko ores of Japan. Models built especially on Kuroko deposits of Japan and the metal-rich brines of the Red Sea confirmed that the mineralizing fluid was evolved seawater. Thus, although all people working in this area found the active hydrothermal jets at 21°N on the East Pacific Rise to be exciting, exhalations were expected by researchers on ore genesis more than a decade before their discovery. It is a case of a modern feature being predic sil record, and Canadian scientists played a

full role in this development. Part II, comprising 17 case histories, was a mild disappointment to me, although it does help support the contention, in the final chapter, that submarine emanations are a key fenture. The Geco base-metal massive-sulfide deposit (paper 10) is a world-class ore deposit that is described by R. G. Friesen et al., but the giant Kidd Creek deposit does not have a paper even though it has one of the most spectacular case histories in the use of genetic models and airborne geophysics in its discovery. It also is the world's largest producer of silver, Canada's lending producer of four other commodities, and will produce as much copper as a medium-sized porphyry-copper deposit (at an ecological 3 to 4 times the grade of porphyry coppers). Probably only Broken Hill, Australia, is a bigger zinc deposit. The giant Sudbury feature and its famous nickel deposits do not have a chapter either. The huge sediment-hosted Sullivan massive sulfide in the Purcell Supergroup of British Columbia has a chapter, but the huge Cocur d'Alene Pb-Zn-Ag vein deposit (which was once the world's largest silver producer) does not, even though it is just across the Canadi-

an border in the United States and is hosted in the correlative Belt Supergroup. The rea-soning for these kinds of omissions is given in

Many important Precambrian sulphide de posits are not considered in the volume. Abent are those that have been extensively stud ied and for which thorough descriptions and up-to-date genetic interpretations have recently been published. Specifically included are newly discovered deposits and older ones for which

An excellent example of a previously unde-scribed world-class deposit is the chapter on the Crandon Zn-Cu deposit in northern Wisconsin by E. R. May and P. G. Schmidt, Furthermore, the airborne geophysical techniques of aeromagnetics and electromagnetic played a key role in discovery of the extent of the metavolcanic belt and the Crandon deposit itself. D. J. Robinson and R. W. Flutchinson propose a novel and controversial volcanogenic-exhalative origin for the nickel-rich massive sulfide deposit at Redstone, Timmins, Ontario. The book should also be of interest to investigators of the deep-sea polyme tallic deposits for comparison and model building. So although the book does not furnish "one-stop shopping" on descriptions of Precambrian ore deposits of Canada, it is the only or the best source on a number of them. It is sufficiently comprehensive so that it will lead readers to other references on key deposits which may not be adequately discussed. At \$57, probably not many geophysicists will want the book for their personal libraries, but they should make sure that their institution has it, and taking a look through it would be very worthwhile. I recommend beginning with the summary chapter at the end.

Bruce R. Doe is Assistant Chief Geologist for the Eastern Region, U.S. Geological Survey, MS 953,

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Geomagnetism of Baked / Clays and Recent Sediments

K. M. Greer, P. Tucholka, and C. E. Barton (Eds.), Elsevier, New York, xv + 324 pp., 1983, \$53.25.

Reviewed by Edward A. Mankinen

This book is an outgrowth of the symposium entitled "Time Scales of Geomagnetic Secular Variations," which was held at the 4th Assembly of the International Association of Geomagnetism and Aeronomy (Edinburgh, U.K., August 1981). The volume includes many of the papers presented, which de-scribed paleomagnetic results from both archeologic materials and Holocene geologic deposits, as well as contributions solicited from other researchers in the fields of archeomagnetism and paleomagnetism. In a remarkably short time after the conclusion of the symposium the editors were able to elicit. edit, and assemble a large body of material from 40 individuals into a thoughtful, well-

The book is divided into four chapters; the individual contributions constitute sections within each chapter. A comprehensive reference list concludes each chapter. The first

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Subscription price to members is included in annual dues (\$20 per year), Information on institutional subscriptions is available on request. Second-class postage paid at Washington, D. C., and at additional mailing offices. Eas, Transactions, American Geophysical Union (155N 0090-3941) is published weekly by

American Geophysical Union 2000 Florida Avenue, N.W. Washington, DC 20009

Cover. Maps of the ionospheric electron density, ion temperature, electron temperature, and line-of-sight drift as a function of UT and altitude during the May 30, 1984, annular eclipse of the sun. The measurements were made by the Millstone Hill incoherent scatter radar, using a 46-m steerable antenna pointed southwest at an azimuth of 225° and an elevation of 15°. The intersection of the radar beam and center line of the eclipse was at 37°N, 78°W at an altitude of 300 km. At this lo cation the eclipse was centered at 1641 UT. The electron density at 300 km decreases to 70% of its value before and after the eclipse, with the minimum occurring 30 minutes after the center of the eclipse. The ion tomperature shows only small change. The electron temperature shows a 750 K decrease centered on the eclipse time. The line-of-sight velocity hows a perturbation near the beginning the cclipse. (Figure courtesy of J. M. Holi, Massachusetts Institute of Technolo gy Haystack Observatory, Westford, Mass. ee news item "1984 Solar Eclipse." conributed by J. E. Salah.)

AGU STUDENT MEMBER SPECIAL

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two chapters are the shortest and provide a background for the rest of the book by discussing the processes by which various materials become magnetized and the methods that can be used to determine their age. Discussed in chapter 1 is the acquisition of a thermoremanent magnetization (TRM) by baked clays, a detrital, or depositional, remanent magnetization (DRM) by unconsolidated sediment, and the processes by which these magnetizations are sometimes modified or destroyed. Also discussed is the lesser-known but archeologically important shear remanent magnetization (SRM), which is acquired when mud is thrown into a mold during the manufacture of adobe bricks. Topics covered in chapter 2 include a description of palynologic correlation as a method of relative dating, the application of radiocarbon dating to sediment, tree ring and varve chronologies, sedi-ment-dating methods using radioisotopes other than ¹⁴C, and possible applications of the thermoluminescence (TL) dating method to both baked clays and sediment. Although they are fairly brief, the individual sections are well referenced and generally provide the reader with a sense of the capabilities and limitations of each method. Particularly welcome is a discussion of the sources of error in

voted to studies of archeologic materials. One

been to construct curves of geomagnetic secular variation so as to obtain information on

the nature of the field and to use these refer-

ence curves as dating and correlation tools at

other archeologic sites. For secular variation

must include measurements of paleointensit

ning of this chapter is devoted to a discussion

which is a mainstay in paleomagnetic re-search, encounters special problems when it is

applied to archeologic materials, and there-fore the reliability of some of the earlier in-

tensity results is not known. The situation,

however, is not so bleak as some of the dis-

cussion may imply, and newer methods have

been devised to overcome some of the earlier

difficulties. Various alternating-field demag-

netization techniques that are currently being

well. The rest of the chapter describes the re-

investigated seem to show some promise as

sults of archeomagnetic investigations in dif-ferent regions of the world. Not only are

summaries of previously published work pro-

vided, but some new data and references to

work in press are also included, which should

ensure that this book will not rapidly become

out of date. Although an enormous amount

of work is required to construct the reference

curves, much progress has been made in sev-

eral of the regions discussed. Because so

many archeomagnetic data are thus com-

see how well the reference curves agree be-

some features can be correlated. This chapter

cheomagnetists and paleomagnetists but also

to other geologists studying the Holocene, who could benefit from the use of the secular

though archeomagnetic studies are providing

many details on past secular variation, each

point on a reference curve is a geologically "instantaneous" reading of the geomagnetic field. Archeologic materials do, however,

have the advantage of being able to provide accurate, absolute values of paleointensity.

Lacustrine sediment, on the other hand, can

provide essentially continuous records of sec-

of results from rapidly deposited sediment in

ular variation but only relative paleointensi-

variation records being developed [ql Al-

will be of particular interest not only to ar-

tween studies and over how wide an area

studies to achieve their full potential, they

as well as paleodirection, and so the begin-

of archeointensity methods. The Thelliers'

method of paleointensity determination.

of the main objectives of these studies has

radiocarbon dating, which serves as a reminder that analytically precise ages do not neces-Survey, Menlo Park, Calif. sarily guarantee geologic accuracy. Chapter 3, the longest in the book, is de-

tralia. The chapter concludes with a discussion of statistical methods of data analysis, including data smoothing, comparison of related records, and spectrum analysis.

Overall, I find little to criticize in this book. Preparation of the text as camera-ready copy probably contributed to its timely publication. However, it is also somewhat harder to read than if it had been typeset, particularly because many of the punctuation marks seem to have become faint and indistinct during the final reduction. Because a few of the figures may not be entirely clear to the uninitiated reader, the individual contributors might have paid more attention to the figure captions, although most of the figures are well prepared and effective. In general, the individual sections seem to be of appropriate length for the topics addressed. The text is well edited, and there are very few typographical errors and little remaining jargon, such as "seriation dating." The editors have also succeeded in their intention of having the volume "... read as a book rather than as a collection of papers." Students and professional geologisis alike should find it a valu-

Edward A. Mankinen is with the Geologic Division, Branch of Isotope Geology, U.S. Geological

Career and family: **Making It Work**

AGU Fall Meeting Wednesday, December 5 6:00-8:00 P.M. Crystal Ballroom San Franciscan Hotel

Connie Sancetta of Lamont-**Doherty Geological Observatory** will moderate a discussion of how best to balance active involvement in a career with having and ralsing children. Panelists will be Tanya Atwater (University of California, Santa Barbara). Suzanne Beski-Diehl (Michigan Technological University), Laurie Brown (University of Massachusetts) and Sylvia Garzoli (Lamont-Doherty Geological Observatory).

This program has been arranged by the AGU Education and Human Resources Committee, Refreshments will be available.

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Replies to ads with box numbers should be addressed to Box, American Geophysical Union, 2000 Florida Avenue, N.W., Washing-

on, DC 20009. oll free 800-424-2488.

POSITIONS AVAILABLE

Fuculty Position in Structural Geology/Tectonica.

The Department of Marine, Earth and Atmospheric Sciences, North Carolina State University, has a tenure track opening at the Assistant or Associate Professor level in the area of structural geology/tectonics. The position will be filled for the beginning of the Falt 1985 term. The department currently has \$1 full-time faculty, including 12 geologists and geophysicists.

The successful applicant will be expected to have completed the PhD degree. Courses to be taught include undergraduate structural geology as well as courses in structural analysis, tectonics, or other areas of research activity. He or she additionally will be expected to develop a vigorous program of sponsored research and to direct graduate student research projects at the MS and PhD lovel.

Please send complete resume and the names of at least three references to V.V. Cavaroc, Search Committee Chairman, Department of MEAS, North Carolina State University, Raicigh, NC 27695—8208; phone (919) 757-2219, Applications will be considered as received, with a closing date of January 15, 1985.

North Carolina State University is an equal opbined into a single source, the reader can easily obtain a good idea as to the current state of secular variation research and can readily

985.
North Carolina State University is an equal op-ortunity/affirmative action employer.

Senior Hydrologist. The Monterey Pertinsula Water Management District invites applications for a position of SENIOR HYDROLOGIST. The MPWMD is a small, progressive planning and regulatory agency that deals with problems ranging from designing a new water supply project to groundwater management and riverbank and watershed erosion. The preferred candidate will have a MS or PhD and three years of work experience; be a generalist, able to deal with both surface and groundwater; be able to do independent research, applying modern techniques to applied problems; be able to communicate effectively with the Board of Directors and the general public. Salary comparable to USGS. The MPWMD is an equal opportunity employer, and hopes to fill the position by January 1985. Send resume to Bruce Buel, General Manager, MPWMD. P.O. Box 85, Monterey, CA 95940. usar variation out only relative pateometris-ties. Thus these two types of studies can be complementary, and chapter 4 describes the progress that is being made in the study of unconsolidated sediment from various envi-ronments. The editors begin this chapter with a brief description of coring devices and measurement procedures, followed by summaries Europe, North and South America, and Aus

Postdoctoral and Research Associate Positions/
INSTOC. The Institute for the Study of the Continents (INSTOC) invites applications for postdoctoral and research positions in programs involving
study of the continental crust, including COCORP,
or to initiate new programs of crustal study. The
Ph.D. is required, and experience in geophysics or
geology is desirable. Send vitae, list of publications,
and letters of recommendation to Professor Jack Oliver, Institute for the Study of the Continents, Snee
Half, Cornell University, Ithaca, NY 14853.

An equal opportunity/affirmative action employ-

Congressional Science Fellowship. Opportunity for a one-year assignment (September to August) or the staff of a congressional committee or a House or Senate member as an advisor on a wide range of scientific issues affecting public policy questions. Individuals who are AGU members and U.S. residents are invited to apply. A broad background in science is expected, as the various duties entailed require the applicant to be articulate, literate, flexible, and able to work well with people from diverse professional backgrounds.

Public policy background is not required although such experience and/or demonstratable interest in applying science to the solution of public problems is desirable.

The followship carries with it a stipend of up to

applying science to the solution of public problems is desirable.

The fellowship carries with it a stipend of up to \$28,000 plus travel allowances.

How to apply:

Candidates should submit a letter of intent, a curriculum vitae, and three letters of recommendation. The letter of intent should include a statement of why the fellowship is desired, how you qualify for it, what issues and congressional situations interest you, what role you envision as a congressional science fellow, and what outcome you hope for in relation to career goals. The individuals from whom you request letters of recommendation should discuss not only your professional competence, but also other aspects of your background that make you particularly qualified to serve as a Congressional Science Fellow.

Sedimentary Geochemist/Geologist. The Department of Geological Sciences at Lehigh University announces the availability of a tenure track position at the Assistant Professor level starting September 1, 1985. The successful candidate will be expected to teach both graduate and undergraduate courtes and to maintain an active research program. Primary consideration will be given to those whose research experience and professional interests are in low-temperature sedimentary geochemistry, but outstanding randidates in related research areas will also be considered. The Department of Geological Sciences has nine faculty members and some 35 graduate students. Research facilities include automated XRF and XRD within the department; electron microprobe; analytical SEM, TEM, AA, etc. are available on campus. Respond with a letter describing research interests, full curriculum vita, and the names of three references by December 15, 1984 to: Charles B. Sclar, Chairman, Department of Geological Sciences, Lehigh University, #31 Williams Hall, Bethlehen, Pennsylvania 18015. Applications received after December 15 may not be given full consideration.

Lehigh University is an equal opportunity/affir-

sideration.

Lehigh University is an equal opportunity/affirmative action employer. Women and minorities are especially encouraged to apply.

Selmologist/Northera Illinois University, Department of Geology. The Department of Geology seeks to fill a tenure track position in Geophysics at the rank of Assistant Professor beginning August 15, 1985. Candidates with pustdoctoral experience in applied seismology and whose research will involve students in field programs are most desired. The successful candidate will be expected to participate in and enhance an aggressive research uro-The successful candidate will be expected to participate in and enhance an aggressive research program, teach at both the graduate and undergraduate levels, and interact with faculty and students in geophysics, geology, geochenistry and hydrology. The Department, which offers both the M.S. and Ph.D. degrees, is composed of 15 faculty active in a wide range of research programs. Pertinent equipment owned by the Department includes a mini-continuter, several magnetometers, and arabineters. ment owned by the Department includes a mini-contputer, several magnetometers and gravimeters, a seismometer and a marine seismic system. Appli-cants should send a letter of application, resume, statement of research interests, and the names of three references to: Chair, Geophysics Search Com-mittee, Department of Geology. Northern Illinois University, DeKalb, 11, 60115. Application deadline is January 15, 1985. Northern Illinois University is an equal opportu-nity/affirmative action employer.

Saint Louis University. The Department of Earth and Atmospheric Sciences invites applications for a tenure-track assistant professor position in geophysics effective for the fall of 1985. We seek an individual with broad interests who will complement active research programs in seismokogy and earth structure. Preference will be given to candidates who can both pricing courses in the total extractors are compared. teach existing courses in plate tectonics, geomagne-tism and/or geoelectricity. The sucressful candidate must have a Ph.D. degree and will be expected to nust have a Ph.D. degree and will be expected to maintain an active research program, to teach geophysics courses at the mulergraduate and graduate levels, and to supervise graduate student research. The application deadline is January 15, 1985. Applicants should send a curricultum vitae, a statement of research and teathing interest and the names of 4 professional references to:

Dr. Brian J. Mitchell, Chairman Department of Earth and Atmospheric Sciences Saint Louis University PO Box 8099—Ladede Station St. Louis, MO 63156.

Saint Louis University is an affirmative action/equal opportunity employer.

College of Geosciences/University of Oklahoma College of Geosciences/University of Oklahoma.

Applications and monitrations are invited for the pasition of Director of the School of Geology and Geophysics. The Olector is expected to have a Ph.D. or equivalent, a strong, ongoing research program and administrative experience; industrial experience helpful; field of geological specialization open; to begin July 1, 1985; salary to be negotiated. In 1986, the School will move into the new 300,000 sq. ft. Energy Center along with other elements of the College of Geosciences; the Oklahoma Geology Survey; and the School of Petroleum and Geological Engineering and the School of Chemical Engineering and Materials Sciences, both from the College of Engineering.

Applications with curiculum vitae, names and address of three references, and/or nominations should be sent to:

should be sent to:
Francis G. Stehli, Dean
College of Georgicences
University of Oklahoma
60l Elia Street, Room 438C
Norman, Ok 73019.
Consideration of annitonings will begin

Consideration of applications will begin January 1, 1985. The University of Okkihoma is an Equal Opportunity/Affirmative Action Employer.

Research Groundwater Hydrologist

Argonne National Laboratory's Geoscience and Engineering Group seeks a groundwater hydrologist to conduct innovative research and to assist in the assessment of groundwater problems related to energy technologies.

Considerable knowledge of groundwater transport processes and experience in the use and development of related numerical models are required. Experience in research on the relation ships between field data and model results is desirable. Strong written and verbal skills are necessary. The levels of knowledge and skills required will typically have been acquired through advanced formal education and several been documented in publications.

On-going studies related to the siting of high-level radioactive waste repositories provide a variety of challenging groundwater problems. Argonne offers excellent computing and support facilities which will provide the opportunity to initiate activities in basic or applied groundwater research motivated by other energy/environment concerns.

Responses should be directed to: Roseile L. Bottino. Box EKS-22537-80, Argonne National Laboratory. 9700 South Cass Avenue, Argonne, IL 60439

An Equal Opportunity/ Affirmative Action Employer Hydrologist. Monterey, California. \$1,887 to \$2,293 per month plus benefits. Requires BS in Hydrology, computer programming skills and three years experience. Apply by 5:00 p.m. November 15, 1984. Send resume to Monterey Peninsula Water Management District, P.O. Box 85, Monterey, California 93940. Call 408-649-4866 for job flyer.

Texas Tech University/Geophysicist or Clistic Sedimentologist. The Department of Geosciences at Texas Tech University seeks applications for a tenure track position in the fields of geophysics or clastic sedimentology to begin August 1985. Rank and salary will be commensurate with qualifications. The Ph.D. is required. Entry-level applicants will be given preference. The primary responsibility would be to teach both graduate and undergraduate courses in geophysics or depositional systems and sedimentology, his/her specialty, and introductory geology. The person will be expected to infitate a research program and to direct MS and Ph.D. graduate students. Send a letter of application with complete curriculum vitae and names of three references, P.O. Box 4109, "ITU, Lubbock, TX 79409." Texas Tech is an equal opportunity/affirmative action employer. Applications deadline: January 31, 1985.

seismologist/University of Utah. The Department of Geology and Geophysics at the University of Utah seeks applicants for a tenure track faculty position in seismology at the assistant to associate professor level. Applicants with backgrounds and specialties in seismic imaging, seismic reflection or theoretical seismology will be given preference. The individual will be expected to teach undergraduate and graduate courses and to pursue an active research program with graduate students. A seismic imaging laboratory with a VAX 11/730, FPS array processor, plotters, and processing and synthetic seismogram software is available to the successful candidate. Current research in seismology includes: earthquake research utilizing a PDP 11–70 computer; monitoring of the Intermountain seismic belt by an 85 station telemetered network utilizing an online PDP 11–34 computer; major experiments in seismic refraction and reflection proliting for crustal structure; and allied research in tectonophysics. The opportunity exists to participate with several other faculty in an integrated program of rectonics, seismology, and sedimentology directed toward crustal studies and petroleum exploration. The geophysics component of the department has active research and teaching programs in chectrical and electromagnetic methods, thermal properties of the earth, potential fields, and seismology. The department has close associations with the numerical analysis and data processing groups in computer science, electrical engineering and mathematics. The closing date for applications is December 31, 1984, and the appointment date is September 15, 1985. A Ph.D. is required for this josation. Applicants should submit a vita, transcripts, a letter describing his/her research and teaching goals and names of five persons for teference. Qualified persons should send their applications to William P. Nash, Chairman, Department of Geology and Geophysics. University of Utals, Salt Lake City, Utals 841 (2–1183.

The University of Utals is an equal opport

Affirmative action employer.

Paculty Positions in Geochemistry and in Neotectopics. The State University of New York at Binghamton invites applications for tenure track positions in these two areas beginning August, 1985. The appointments will be at the assistant or junior associate professor level and will require completion of the PhD prior to this date. The candidates must demonstrate potential to develop a productive research program as well as teach at the undergraduate and graduate levels.

The geochemist should have primary interests in some aspect of low temperature geochemistry. The neotectonist should have some interest and experience in study of sedimentologic and/or geomorphic processes and products as well as tectonic ones. Applicants should send a resume and names of three persons who can be contacted for references to: J.R. Beerbower, Department of Geological Sciences and Environmental Studies, State University of New York, Binghamton, NY 13901.

The State University of New York is an affirmative action/equal opportunity employer. The closing date for this position is 15 December 1984.

Visiting Appointments/Princeton University. A limited number of one-year visiting appointments, with the possibility of renewal, are available on a competitive basis for new and established Ph.D.'s to carry out research in dynamics and predictability of the atmosphere and oceans, climatology, atmospheric and oceanic chemistry, basic geophysical fluid dynamics, and solid earth geophysics. Successful applicants will have access to the facilities of the Geophysical Fluid Dynamics Laboratory/NOAA. Information and application forms can be obtained from: Chairman, Visiting Scientist Selection Committee, Geophysical Fluid Dynamics Program, Princeton University, P.O. Box 308, Princeton, New Jersey 08542.

Princeton University is an equal opportunity em-

Postdoctoral Position/Oregon State University.
Research Associate (postdoctoral), at Oregon State
University's Cooperative Institute for Marine Resources Studies. Expertise in physiological and
chemical ecology with interest in interactions of hydrothermal vent fauna with the unique biogeochemical properties of their environment. Familiarity
with state-of-the-art analytical techniques (GC, GC/
MS, HPI.C) highly desirable. One (1) year, renewnable for a second year subject to approval. Send
C.V., names and addresses of three (3) references O November 1984 to Director, CIMRS, Hatfield Marine Science Center, Newport, Oregon 97365, OREGON STATE UNIVERSITY, AN AFFIR-MATIVE ACTION/EQUAL OPPORTUNITY EM-PLOYER, COMPLIES WITH SECTION 503 OF THE REHABILITATION ACT OF 1973.

THE REHABILITATION ACT OF 1973.

Harvard University/Faculty Position in Petrology. The Department of Geological Sciences, Harvard University, invites applications for a faculty position in petrology. We are interested in persons concerned with the mineralogy and the major and/or trace element chemistry of metanorphic and igneous rocks in relation to their geologic and tectonic setting. Experience with modern methods for the study of natural rocks, both in laboratory and in the field, is essential. The successful applicant must have the Ph.D. degree by the time of appointment and demonstrated capabilities to conduct original research and to teach both undergraduate and graduate students. The appointment will be made at the Assistant or Associate Professor level depending on qualifications and experience. The 1984/85 salary ranges are \$26,600—\$28,200 for Associate Professor. Appointments are made for an initial term of up to five years. Interested applicants should send vita, bibliography, and names of three references to: Professor Adam M. Driewonski

Harvard University
Hoffman Loboratory
20 Oxford Street.

Cambridge, MA 02138.

Harvard University is an equal opportunity/affirmative action employer. Women and minorities are encouraged to apply.

DEAN COLLEGE OF ENGINEERING Colorado State University

Nominations and applications are invited for the position of Dean of the College of Engineering. Colorado State University is a comprehensive research university of 18,000 students, located 60 miles north of Denver. The College of Engineering has 1,400 undergraduate and 400 graduate students in the departments of Agricultural and Chemical, Civil, Electrical. and Mechanical Engineering, Atmospheric Science and the Engineering Science major. Each department offers MS and PhD programs. The College has 110 faculty who annually conduct about \$15M of contract and grant research in support of the graduate programs in the five departments. A new computer-assisted engineering center serves the entire College. Applicants must have a doctorate, be tenurable in one of the departments, have a distinguished record of publications in scholarly journals, experience in contract/grant activities, and have substantial teaching and administrative experience. The Dean is expected to provide leadership for the undergraduate and graduate teaching programs as well as the research activities. Salary will be commensurate with comparable positions at other land grant institutions. Applicants should send a letter of intent, a résumé and also ensure that five letters of reference are sent to Dr. Robert D. Phemister, Dean's Search Committee, Office of the Dean, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, CO 80523. Applications must be received by January 15, 1985.

Colorado State University is a EEO/AA employer. Equal Opportunity office: 314 Student Services Building, Colorado State University, Fort Collins, CO 80523.

South Dakota School of Mines and Technology.

The Department of Geology and Geological Engineering is seeking applicants for a full-time tenure track position in geological engineering beginning fall 1985. Applicants should have a Ph.D. degree or continensurate experience including "Registration" in geotechnical or petroleum engineering or geohydrology and will be expected to teach at both undergraduate and graduate levels as well as conduct an active research program in their field of specialization.

tion.

The Department has an undergraduate enrollment of 200 majors and a graduate enrollment of 60. Field applications are emphasized. Interested persons should send a resume and three letters of recommendation to Alvis Lisenbee. Department of Geology/Geological Engineering, South Dakota School of Mines and Technology, Rapid City, SD 57701.

Deadline for applications is February 1, 1985. SDSM&T is an equal opportunity employer.

SDSM&T is an equal opportunity employer.

Graduate Fellowships/University of Oklahoma.

The School of Geology and Geophysics offers fellowhips for Ph.D. study in each of the following broad disciplines: (1) origin, ascent, and fractionation trends in magmas and associated ore deposits; (2) formation and tectonic evolution of continental lithosphere, including geophysical properties and structures of the upper crust; and (3) sedimentary processes, including organic and inorganic diagenesis, evolution of hydrocarbons, and correlation using biostratigraphic methods. Average fellowship stipends are for \$10,000/9 month and are renewable annually on a competitive basis. Fellowship awards include a waiver of out-of-state tuition and fees.

The School of Geology and Geophysica presently consists of 19 full-time faculty. Research facilities in the school include a stable isotope laboratory; organic geochemistry laboratory; computer automated X-ray diffraction and fluorescence equipment; scanning electron microscope with energy disperaive analyzer; transmission electron microscope; fission-track dating laboratory; fluid inclusion microthermometry laboratory; 2 kb hydrothermal laboratory for phase equilibrium experiments; high-pressure rock mechanics laboratory; paleomagnetic laboratory with a cryogenic magnetometer and thermal and AF demagnetization apparatus; 24high-pressure rock mechanics laboratory; paleomagnetic laboratory with a cryogenic magnetometer and thermal and AF demagnetization apparatus; 24-, 48-, and 192-channel digital seismic recording systems; a VAX 11-785 computer with high-resolution graphics and image display terminals, with seismic and image processing software; and a 84,000 volume geology and geophysics library located in the department.

For further information on faculty and active research projects, contact: Kevin Growley, School of Geology and Geophysics, University of Oklahoma, 830 Van Vleet Oval, Norman, OK 78019.

Sedimentary Petrologiat/Wright State University.

The Department of Geological Sciences invites applications for a tenure track position in sedimentary petrology, at the assistant professor level beginning September 1, 1985, Candidates must have an interest in carbonate rocks and basin analysis. Preference will be given to people capable of teaching introductory paleontology. The Department has a large M.S. program and wishes to expand their sedimentary petrology group. Applicants should expect to complete all requirements for the Ph.D. in geological sciences or related field by September 1, 1985. Send resume and three letters of reference to Chairman, Search Committee, Department of Geological Sciences, 260 Brehn Laboratory, Wright State University, Dayton, Ohio 45455, Glosing date for applications is January 15, 1935.

Wright State University Is an equal opportunity/affirmative action employer.

A WORKSHOP ON ODP DRILLING IN THE N.E. PACIFIC

INPAC (International N.E. Pacific Activities Consortium) announces a workshop to further define a drilling program in the N.E. Pacific using the new ODP drilling ship SEDCO/8P 471, which is scheduled to be in the region in summer 1990. The workshop will take place at the School of Oceanography, University of Washington on February 20-22, 1985. The three-fold focus of the proposed integrated, multi-disci-plinary drilling program will include: 1) ridge crest processes on the Juan de Fuca Ridge, 2) convergent margin pro-cesses off the Washington, Oregon, and British Columbia coasts, and 3) paleo-oceanography of the N.E. Pacific. The purpose of the workshop will be to further define major scientific prob-lems that can be addressed by drilling, to identify possible drill sites, to pre-sent the results of relevant un-going scientific programs in the area, and to organize the data gathering and synthesis necessary to write a comprehensive drilling proposal to JOIDES. The two and one half day workshop is open to all parties who have an interest in the drilling program in the N.E. Pacific. Interested parties should write to the INPAC Committee, c/o Paul Johnson, School of Oceanography WB-10, University of Washington, Seattle, WA 98195, prior to 1 December 1984.

Seismologist. The Department of Geological Sciences at the University of Texas at El Paso anticipates a tenure track position for a seismologist beginning Septeniber I. 1985. Applications should have a strong commitment to research and interest which complement our ongoing efforts in lithospheric seismology. Our geophysics group is generally well equipped in terms of field, laboratory, and computational facilities. There are three geophysicists in the Department of Geological Sciences with supporting faculty in the Physics Department. The graduate student enrollment in the program is 15-20. A doctorate is required, and the appointment will be at the Assistant Professor level. The salary level will be competitive Send resume and three letters of reference to: Dr. G.R. Keller, Chairman, Department of Geological Sciences, University of Texas 12 Paso, El Paso, Texas 79968—0555. Chairna date for applications is January 31, 1985.

The University is an equal employment apportunity/allirmative action employer.

Physical Oceanographers. The Physical Oceanography Branch of the U.S. Naval Oceanographic Office seeks full-time Oceanographers for the study of the effects of oceanic current and thermal/density structure on undersea systems using data collected from various platforms for a variety of projects. The projects involve the collection, analysis and recognize of physical oceanographic data directly appropriate of physical oceanographic data directly appropriate of physical oceanographic data directly appropriate.

The projects involve the collection, analysis and re-porting of physical occanographic data directly ap-plicable to relevant Navy environmental require-ments. Up to 50% field duty may be required. Mutiple vacancies at the GS-7, 9 and 11 levels are available depending upon qualifications and experi-ence and will remain open until filled. Salary range: \$17.221 to \$35,150. \$17,221 to \$35,139.

\$17,221 to \$33,139.

Please contact (for required forms): Debra Staples, #N00-72(84), Commercial 601-688-5720, Autovon 485-5720, or FTS 494-5720, U.S. Naval Oceanographic Office, Management & Personnel Division, Personnel Operations Branch, Code 4320, Bay St. Louis, NST'L, Mississippi 39522.

University of Utah: Structual Geology/Tectonics/
Tectonophysics. The Department of Geology and Geophysics at the University of Utah seeks applications for a tenure track position in structural geology, tectonics or tectonophysics. It is anticipated that this position will be filled at the assistant professor level, but applications by more senior persons will be considered. The position requires a Ph.O. with emphasis in structural geology, regional tectonics or tectonophysics. The new faculty member will have the opportunity to teach in the area of his or her specialty and may also be assigned introductory level courses. The successful candidate will be expected to establish a vigorous research program involving to establish a vigorous research program involving graduate students. The person who fills this position will join an active program in structural geology and tectonics that includes both field projects and integrated geology/geophysics am mechanics/fluid chemistry studies of structures in the western Cartillera. There is an excellent upportunity to get into chemistry studies of structures in the western Cordillera. There is an excellent opportunity to collaborate with other faculty in structural geology, sedimentology, geophysics, geochemistry and petrology. A vita, copies of publications, names of three persons that may provide references, and a letter outlining the candidate's research and teaching interests should be sent to Dr. William P. Nash, Chairman Description of Colorana Commission. teresis should be sent to Dr. William F. Nash, Chair man, Department of Geology and Geophysics, Uni-versity of Utah, Sah Lake Gity, Utah 84112–1183. Deadline for receipt of applications is December 31 1984 with the appointment starting in September

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ffirmative action employer.

Postdoctoral Fellowships at the Woods Hole Oceanographic Institution

OCEAN SCIENCE and ENGINEERING Applications are invited from new or recent doctorates in acience or engineering with interests in physical oceano graphy, marine chemistry, marine, geology and geophys-ics, biological oceanography, or oceanographic engineering. Recipients of awards are selected on a com-politive basis, with primary emphasis placed on research promise.

vahips are awarded for one year with a stipend of retionships are awarded for one year with a sipend of \$23,100 plus group health insurance and a modest research budget. Recipients are encouraged to pursue their own research interests independently or in association with resident staff Completed applications must be received by 18 January 1988 for 1985-86 awards. Awards will be announced by 1 March. Write for application forms.

Dean of Graduate Studies P.O. Rox S Woods Hale Oceanographic Institution Woods Hale, Massachusetts 02543 Kqual Opportunity Affirmation Action Institution

Scismologist/Oblo State University. The Department of Geology and Mineralogy, The Ohio State University, invites applications for a tenure-track position for a seismologist with research interests in crustal geology and tectonics. The successful applicant must be prepared to assist in teaching exploration geophysics courses, advanced topics in his/her speciality, conduct research, and supervise graduate students. Postdoctoral or industrial experience is desirable. Runk and salary commensurate with experience and research record. Please send applications or nominations to:

or nominations to:

Dr. Ralph R.B. von Frese
Chairman, Search Committee
Department of Geology and Mineralogy
The Ohio Sinte University
Columbus, OH 43210.
Telephone: 614-422-5035 or 422-7221.
Applications should include a resume, a statement
of research interests and three persons whom we
may contact for recommendations. The closing date
for applications is December 1, 1984; appointments
will be effective no later than October 1, 1985. Addilional information can be obtained by writing or filional information can be obtained by writing or alling the chairman of the search committee. The Ohio State University is an equal opportuni-

Cosmochemistry Faculty Position/University of Arizona. The Department of Planetary Sciences and the Lunar and Planetary Laboratory invite applications in a continued search to fill a state-funded, tenure track position in cosmochemistry. The reasume in a continued search to fill a state-funded, tenure track position in cosmochemistry. The area of specialization within Cosmochemistry. The area of specialization within Cosmochemistry is open. The appointment involves research, teaching, and the supervision of graduate students. The successful candidate will be either at a justice level with extraordinary promise of scientific accomplishment, as well as the potential for developing substantial leadership capabilities and an international scientific reputation, or will be at a senior level having already demonstrated these qualities. Applications, including a resume and the names and addresses of four individuals who could serve as professional references, should be sent, by December 31, 1984, to Professor Eugene H. Levy, Head, Department of Flanetary Sciences, University of Arizona, Tucson, AZ 88721.

The University is an equal opportunity/affirma-

The University is an equal opportunity/affirma-

AGU STUDENT

MEMBERS : Special 50% discount on "paid & carried" books at the AGU Fall Meeting. Ask at booth for details.

Professor (Research)/Stanford University/Plasma Physica, EM Waves, Space Physics. We are seeking a senior person who has demonstrated scientific, managerial, and leadership qualifications in one or more of the following disciplines: Space Plasma Physics, electromagnetic waves, and solar-terrestrial physics. We expect the successful candidate to have established an outstanding reputation documentable through professional writings or other evidence of personal technical creativity, letters of reference trons recognized research leaders in the disciplines mentioned above, and/or awards and other recognizion from appropriate professional societies.

It is expected that this individual will develop a research program in one of the disciplines given above working in coordination with ongoing programs within the STAR Laboratory and, poosibly, with other activities within the Stanford Center for Space Science and Astrophysics. It is expected that this individual will have a strong background in experimental activities in either laboratory or in the field, including the environment of space; experimental activities in either laboratory or space plasma physics would be regarded as good qualifications. However, close association with theoretical developments in plasma physics and/or electromagnetic theory will clearly be desired. It is also expected that the individual will have a demonstrated capability for securing federal or other research grant support, or be deemed by the selection committee of being capable of securing such funds.

It is anticipated that the person chosen will devote the major part of his or her time to research activities. However, there is an opportunity for participation in academic responsibilities of the Electrical Engineering or graduate students.

The Chairman of the selection committee for this position is Professor Robert A, Hellinell, Professor of Electrical Engineering, Space, Telecommunications, and Radioscience Laboratory, Stanford University, Stanford, California 94305. Other members o

High Alditude Observatory Scientific Visitor Program/NCAR. Scientific visitor appointments at the High Altitude Observatory are available for new and established Ph.P's for up to one year to carry out research in solar physics, solar-terrestrial physics, and related subjects. Applicants should provide a curriculum vitae, including education, work experience, publications, the names of three scientists familiar with their work, and a statement of their research plans. Applications must be received by 15 January 1985 and they should be sent to: The HAO Visitor Committee, High Altitude Observatory, National Center Atmospheric Research, P.O. Box 3000, Boulder, Colorado 80307-3000.

NCAR is an Equal Opportunity/Aftirmative Action Employer.

Yale University/Solid Earth Geophysics. The Department of Geology and Geophysics is soliciting applications for a junior faculty position in solid-earth geophysics to begin in the academic year 1985—1986. Areas of interest to the department include scismology, exploration geophysics, ntechanical and physical properties of tocks and numerals, geomagnetism, tectionophysics, and geodesy. Correntum vitae, publications and the names of three or more referees should be sent by December 1, 1984 to Karl K. Turekiam, Chairman, Department of Geology and Corollysics, Yale University, Box 6666, New Havers, C.1 06511.

Yale University is an equal opportunity/affirma-tive action employer and encourages applications from all qualified scientists.

Sedimentologist-Oceanographer/Texas A&M University. Applications are invited for a tenure track faculty position in the general field of marine sedimentology. The position will involve graduate level teaching and supervision of graduate student research. The successful applicant will have demonstrated excellence in or a strong potential for independent research in the field of marine sedimentation. The position is available beginning September 1, 1985, Salary and rank will be commensurate with experience and qualifications. Applicants are invited to submit curricula vita, copies of publications, mantes of three persons who may serve as references, and a letter outlining the applicant's teaching and research interests by December 31, 1984, to Robert O. Reid, Distinguished Professor and Head, Department of Oceanography, Texas A&M University, College Station, Texas 77843.

Texas A&M University is an affirmative action/equal opportunity employer.

University of Arizona/Groundwater Hydrologist.

The University of Arizona, College of Engineering, Department of Hydrology and Water Resources, invites applications for a tenure track faculty position at the Assistant or Associate Professor level in groundwater hydrology. Applicants should have a strong background in hydrogeology, groundwater hydraulics, contaminant transport, and groundwater modeling. The position will involve teaching graduate and undergraduate classes and developing a strong research program in one or more of the above areas. Interested persons should send an up-to-date resume and the names of at least three reforences to:

Department of Hydrology and Water University of Arizona Tucson, Arizona 85721 The University of Arizona is an affirmative action/equal opportunity employer.

Faculty Position in Applied Geophysics or Structural Geology. The Department of Earth Sciences, University of New Orleans, invites applications for a permanent faculty position commencing August, 1985 in APPLIED GEOPHYSIGS or STRUCTURAL GEOLOGY.

The University of New Orleans, located on the south shore of Lake Pontchartrain has 14,00 undergraduate and 2,500 graduate students. The Earth Sciences Department currently has a staff of 11 full-time and four part-time faculty and approximately 150 undergraduate geology majors and 50 master's candidates.

andidates.

The appointee will be expected to teach graduate and undergraduate courses in geophysics-structural geology and general geology, conduct a program of research and supervise theses. The position will be at the assistant professor level. Applications are encouraged from individuals with industrial experience. The Ph.D. degree is required.

Applicants should send a letter outlining interest in position, complete resume, and three letters of recommendation to:

Dr. Louis A. Fernandez, Chairman

Department of Earth Sciences
University of New Orleans

New Orleans, LA. 70148

UNO, a member of the Louisiana State University System. If an equal opportunity/alfirmative action employer.

SUPERVISORY OCEANOGRAPHER **DIVISION LEADER**

NOAA's Pacific Marine Environmental Laboratory is seeking qualified candidates for the position of Division Leader, Marine Resources Research Division. The Division is located at the Hatfield Marine Sciences Center, Newport, Oregon and is engaged in nultidisciplinary research into deep seafloor exchange processes. Current activities include research into the effects of hydrothermal venting, oceanic crustal tectonic pro-cesses, seafloor heat flux, and particle transport in the benthic boundary layer. The Division Leader has responsibility for program planning and budgeting, technical supervision of MRRD stall and liaison with other NOAA components. The Division Leader has primary obligation for leading the MRRD research program, but there is adequate opportunity to conduct individual research.

Candidates should have at least a PhD in physical oceanography and/or geology or related physical sciences. Candidates must have at least three years of professional research experience of which at least one year must have been comparable to the GS-14 level in the Federal service. Candidates must have experience in sea floor processes research including biological, chemical, geological or physical oceanography or they will not be found qualified for this position. Also, candidates must demonstrate that they have the: ability to conduct sea floor processes research; ability to conduct independent research; ability to develop, implement and monitor scientific research programs; ability to supervise a scientific/technical staff; ability to ensure fiscal accountability through management of program funds within budget constraints; ability to make technical presentations, both orally and in writing, and; ability to implement an effective Affirmative Action (EEO) program. Applicants are asked to describe their experience in each of the above seven factors. These responses should be considered as attachments to the basic application form. The salary ranges from \$50,495 to \$65,642 per year. This position is In the Federal Competitive Service; however, persons with no previous Federal service may apply. Applicants should refer to announcement number PMELWASC 84-292 (PM) when submitting applications (SF-171, "Personal Qualifications Statement", available at most Federal agencies) to:

> NOAA, WASC, Personnel Division 7600 Sand Point Way NE Seattle, WA 98115

by November 30, 1984. For further application information call Pete Macias at 206-526-6048. For further details on duties contact Dr. E. N. Bernard, Director, PMEL at

Professor/Chairperson: The University of Utah.

The University of Yeah Department of Civil Engineering is seeking applicants for the position of Professor and Chairperson. Applicants with experience in an academic environment, strong research credentials and proven leadership capabilities are urged to apply. Candidates are sought who have a proven interest in developing research and have demonstrated ability to generate research grants. The position offers professional challenge with potential for future growth, and a unique opportunity to faculty with commitment to scholarly research and education. The appointment is to begin July 1, 1985 and the closing date for the receipt of applications is January 15, 1985, or until the position is filled. Please submit a complete resume and at least three professional references (include addresses and telephone numbers) to:

three professional references (include addresses and telephone numbers) to:

Dr. J.D. Seader
Chairman, Search Committee
Department of Chemical Engineering
University of Utah
Salt Lake City, UT 84112
801-581-8916.
The University of Utah is an affirmative action/
equal opportunity employer.

Geochemistry. The University of California, Davis will fill a permanent, tenure track, faculty position at the assistant professor level beginning Fall, 1985. Candidates having interests in isotope geochemistry and/or the geochemistry of economic deposits are especially encouraged to apply but other specialies in geochemistry will be considered. A PhD degree is required. Responsibilities include teaching at the undergraduate and graduate levels, and research in geochemistry.

Applicants should submit complete vita, a statement of research and teaching interests and the names of three referees. Deadline for application is lanuary 15, 1985. Inquiries and applications should be directed to: Dr Howard W. Day, Department of Geology, University of California, Davis, CA 93616.

The University of California is an equal opportunity/alfirmative action employer.

University of Wisconsin—Madison. The Department of Geology and Geophysics usines applications for an anticipated tenure track position at the assistant professor level in applied geomorphology and/or hydrogeology commencing in August 1985. The applicant should be committed to developing a strong research program as well as teaching undergraduate courses in some aspects of engineering and environmental geology. The Ph.D. is required. Applicants with course work in engineering and an interest in the field application of geologic principles are especially encouraged to apply. Send letter of application outlining your professional goals, transcripts, resume, copies of publications, and three letters of reference to Dr. Mary P. Anderson, Department of Geology and Geophysics, Weeks Hall, University of Wisconsin, Madison, W1 53706. Closing date is January 1, 1985.

The University of Wisconsin is an equal opportunity/affirmative action employer.

University of Wyoming/Department of Geology and Geophysics. The Department of Geology and Geophysics encourages applications from students interested in pursuing graduate research in the fields of igneous and metamorphic petrology and geochemistry. Current research topics, involving field and laboratory studies, include: island are and continental volcanics, petrogenesis of granitic and anorthosite rocks, evolution of the Archean cruss, petrogenesis of mylonitic rocks, aid geothermometry and geobarometry as applied to the evolution of orogenic terranes. Facilities include: an analytical geochemical lab for whole-rock and trace element analysis, a fully automated CAMECA microprobe, two JOEL scanning electron microscopes, a thermal lonization mass spectrometer for analyzing Rb-Sr, Sm-Nd, and U-Th-Pb isotopes, a microthermometry lab, and an experimental petrology. analyzing RO-5r, Sm-Nd, and U-1 h-ra isotopes, a microthermometry lab, and an experimental petrology lab. Applicants should contact:

Petrology/Geochemistry Program

Department of Geology and Geophysics

PO Box 5006, University Station

University of Wyoming

Laramie, WY 82071.

Faculty Position in Geophysics Frankfurt University (FRG)

The Institute of Meteorology and Geophysics at the Johann Wolfgang Goethe-University in Frankfurt (Federal Republic of Germany) has a vacancy at the C3-Professor level. The position is tenured. The appointee will be expected to teach courses in applied geophysics at the undergraduate and graduate levels (in German). Research experience in the area of geoelectric methods would be desirable but not condition. Candidates with other areas of research interest will also be considered.

Application with curriculum vitae, certificates on academic degrees, list of publications and teaching experience should be submitted to the President, Universität Frankfurt, Senckenberganlage 31, 6000 Frankfurt a. M. by November 15, 1984.

Announcements

Chapman Conference on Ion Acceleration

Call for Papers

June 3-7, 1985 Chapman Conference on Ion Acceleration in the Magnetosphere and Ionosphere, Wellesley, Mass. Sponsor: AGU. (Ion Acceleration Meeting, American Geophysical Union, 2000 Florida Avenue, N. W., Washington, D. C. 20009; tel.: 202-469-6903 or toll free 800-424-2488.)

The deadline for submission of abstracts is February 4, 1985.

Recent satellite and rocket data on particle distributions indicate that ions in the ionosphere and magnetosphere are subjected to a variety of energization processes. Wave-particle interactions, electrostatic double layers and shocks, Alfvén waves, anomalous resistivity, E × B drift, magnetic inhomogeneities, and other ideas have been proposed as viable mechanisms responsible for the energization of ions. For the most part, however, coherent theories capable of providing definitive descriptions of the observed ion acceleration phenomena have not yet emerged.

The purpose of this conference is to bring together experimentalists and theoreticians engaged in the study of various aspects of ion energization processes in the magnetosphere. to promote interchange of ideas among these active researchers, and to attempt to achieve some basic understanding of these interesting and complex space plasma phenomena.

Format and Abstracts. Aside from several invited review talks, this conference will consist mainly of contributed oral and poster papers. Topics to be covered by the conference include ion acceleration processes at high latitudes (auroral arc, polar cap, polar cusp, etc.), ion acceleration processes in the plasma sheet and its boundary layer, ion acceleration processes in the equatorial region (geosynthronous orbit, ring current, etc.), ion acceleration processes in active ionospheric and magnetospheric experiments (charged beams, gas releases, etc.), ion acceleration in laboratory plasmas (space simulation and scaled experiments), microscopic ion acceleration processes (wave-particle interactions, double layers, stochastic heating, etc.), and macroscopic acceleration processes (adiabatic processes, shocks, etc.).

All interested in attending and in receiving later information circulars should write to the address given above. For more information on the scientific program, contact Tom Chang, Center for Space Research, Room 37-261, Massachusetts Institute of Technology, Cambridge, MA 02139; telephone: 617-253-7523. Abstracts should follow the standard AGU format, as published in Eas, August 14, 1984. There will be no abstract charge. Authors are requested to indicate their preference for the mode of presentation (oral or poster), although papers may be assigned to either mode depending on the overall plan of the conference program.

Program Committee. R. Arnoldy, M.

Ashour-Abdalla, R. Bostrom, C. G. Falthammar, L. Frank, H. R. Balsiger, D. Gorney, G. Haerendel, D. Hardy, J. P. Heppner, B. K. Hulquist, D. Klumpar, R. Lysak, F. Mozer, H. Okuda, R. Olsen, S. Ossakow, R. Schunk, E. G. Shelley, E. Westcott, D. Williams, D. Winningham, and D. Young, and the coconvenors, Tom Chang, J. R. Jasperse, R. G. Johnson, P. M. Kintner, and M. Schulz.

Student Travel. Limited funding will be available to support student travel expenses to the conference. To apply, call the AGU Meetings Department at the number given above and ask to be sent a travel grant application. The awardees will be selected by AGU in conjunction with the coconvenors. Deadline for travel applications is January 7, 1985.

JECSS Workshop

May 13-18, 1985 Third JECSS (Japan and East China Seas Study) Workshop, Tsukuba Univ., Japan. Sponsors: Japan Marine Science and Technology Center, Oceanographical Society of Japan, Japanese-French Oceanographical Society, AGU. (Takashi Ichiye, Dept. of Oceanography, Texas A & M Univ., College Station, TX 77843.) The deadline for the submission of one-

page abstracts is November 30, 1984. The purposes of this workshop are to ex-

change research results in hydrography, circulation, physical and chemical properties, and sedimentology of the East Asian marginal seas and to plan cooperative programs for field experiments and modeling. Papers in

the topics listed are invited and will be arranged into discussion groups and presentations around the lectures of the invited

Coral Reefs

May 27-June 1, 1985 Fifth International Coral Reef Congress, Tahiti, French Polynesia. (Organizing Committee, Coral Reef Congress, B.P. 562 Papeete, Tahiti, French Poly-

The submission deadline for the 300-word abstracts is December 1, 1984. Abstracts should be submitted in both French and En-

The congress will consist of two principal parts. The first is a symposium entitled "Late Quaternary and Present Sea-Level Changes: Angnitude, Causes, Future Applications." Papers for this symposium are being solicited on topics including global, regional, and local histories of sea level changes, measurement, modeling, and interpretation of such changes, correlation of changes with tectonic, climatic, and oceanographic changes, and prediction of near-future changes for application to a variety of problems, especially those relating to coral reefs. The second part is a seminar entitled "Reef Growth and Sea-Level Change: The Environmental Signature." This seminar, chaired by P. J. Davies, will deal with the identification of the sea level signature in reefs from varied environments, including the analysis of variations of fauna, diagenesis, isotopes, calcification, and sedimentology.

Hydraulics and Hvdrology

Aug. 13-16, 1985 Hydraulics and Hydrology in the Small Computer Age, Orlando, Fla. Sponsor: Hydraulics Division, American Society of Civil Engineers. (William R. Waldrop, TVA Water Systems Development Branch, PO Drawer E, Norris, TN 37828;

tel.: 615-632-4460.) The submission deadline for one-page ab-

stracts is December 1, 1984. Papers are solicited for presentation in technical sessions on topics including computerized data acquisition systems in the labora-

tory and in the field, microcomputer software applications in hydraulies and hydrology, coastal and wetlands processes, groundwater hydrology, surface water hydraulics and hydrology, and hydropower development. Various special tours and exhibits are also

Future AGU Meetings

Fall Meetings

Dec. 3-7, 1984, San Francisco, Califor-

Dec. 9-18, 1985, San Francisco, Califor nia. Abstracts due mid-September 1985. Dec. 8-12, 1986, San Francisco, Califor

Spring Meetings

May 27-31, 1985, Baltimore, Maryland. Abstracts due early March 1985.

May 19-23, 1986, Baltimore, Maryland,

Regional Meetings

Front Range Branch Hydrology Days, April 16-18, 1985, Fort Collins, Colorado Abstracts due December 31, 1984 for professional hydrologists, February 15, 1985 for students; call for papers appeared in July 24, 1984 Eos.

Chapman Conferences

Solar Wind-Magnetosphere Coupling. February 12-15, 1985, Pasudena, Califor nia. Abstracts due November 1, 1984; cal for papers appeared in July 10, 1984 Eas.

Ion Acceleration in the Ionosphere and Magnetosphere, June 3–7, 1985, Boston, Massachuseus. Abstracts due February 4, 1985; call for papers appears in this issue.

Magnetotail Physics, October 28-31, 1985, Laurel, Maryland.

The last Geophysical Year calendar ran October 23, 1984, in Eus.

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Separates

To Order: The order number can be found at the end of each abstract; use all digits when ordering. Only papers with order numbers are available from AGU. Cost: \$3.50 for the first article and \$1.00 for each additional article in the same order. Payment must accompany order. Deposit accounts available.

> Send your order to: American Geophysical Union 2000 Florida Avenue, N.W. Washington, D.C. 20009

Electromagnetics

0730 Electromagnetic theory
ORTHOGOMAL HAPPINGS OF TIME-HARMONIC ELECTROMAGNETIC
FIELDS IN IMMONOCEMENTS (ENDANTSOFROPIC MEDIA
S. Suchy (last. Theoretical Physics, University of
Disastionf, D-4 Disselborf 1, Fed. Bep. Germany),
C. Altins and A. Schatzberg
One of the prarequisitos for loranta' teciprocity
theorem to hold in amisotropic media is the sympetry
(or hermiticity) of the constitutive tensors for paratrtivity, permeability and conductivity, If they are not
symmetric (or hermitian) munily another gedium is introduced for the walldity of the theorem. But if the medium

O785 Tropaspheric propagation
THEORETICAL PREDICTION OF THE OPERATIONAL CHARACTERISTICS OF A DOUBLE POLARIZED MICROWAVE
COMMUNICATION SYSTEM
J.D. Kanullopoulus (Electrical Engineering
Department, National Technical University of
Athens, Athens-147, Greece).
In this paper, a genoral analysis is proposed for the prediction of the operational characteristics of a double polarization microwave communication system where the dominant factor for degradation has been taken to be the
rainfall. This snelysis can be considered as an improved version of previous techniques dealing with the same subject. One of the features of the spatial inhomogenity of the rain sedium as it affects the joint statistical enalysis between rain attenuation and depolarization. (Rain propagation, microwave links).

Red. Sci., Paper 451208.

Geochemistry

1420 Chemistry of bodies of water
MAJOR ION (MEMISTRY AND SENSITIVITY TO ACID PRECIPITATION
OF SIERRA NEVADA LAKES
J.M. Melaci, (Biological Science and Marine Science
Inst., bliv. of (alifarnia, Santa Barbara, CA 93105),
J.L. Stoddard and C.A. Ochs
Most elspine and subalpine lakes of the Sierra Hevada
(California) are vary cliute, weakly buffered calciumbicarbonate waters. Seventy-three lates selected to the
in basins representative of Sierra bedrocks were sampled
in the summers of 1981 and 1982 and have a median
alkilnity of 50 use 1-1 (range, 5 to 1137), and plt of 7
(range, 5.7 to 9.4). The atkalinity of Sierran lates
cannot be predicted from allitude, basin area, or lake
area. The concentrations of sulfate, calcium or
alkalinity in lake waters are positively correlated with
the percent areal coverage of volcanic or calcareous rocks
in the basins. The lakes are not acidified but are
extremity sensitive to increases in acidity of atmospheric
precipitation. (Chemistry of bodies of water, limmology,
water quality.)

Water Pescur. Res., Paper 4V1251,

Hydrology

3130 Groundwater
AN EFFECUTE IDENTIFIABILITY IN AQUIFER PARAMETER IDENTIFICATION AND OPTIMAL PROPING TEST DESIGN

1. N-G. Yeh (Civil Engineering Department, University of California, Los Angeles, California, 90024), N. Z. Sun (Department of Mathematics, Shandoog University, The People's Republic of China)

AN Extended Identificability, called "6-Identifiability", is developed for groundwater bodeling and management, some fundamental concepts are developed for establishing a criterion in connection with the problem of optimal experimental design, such as the design of an optimum pumping test to smalls negutier parameter identification. The proposed "6-identifiability" is based upon the concept of weak uniqueness. The determination of the admissibility The proposed "--identifishility" is based upon the concept of weak uniqueness. The determination of the admissibility of a given design is formulated as a conlinear programming problem. The original constrained problem is transformed into solving a sequence of unconstrained problems by a Penalty Function Mathod. Numerical experiments are conducted to illustrate the proposed concept and algorithm.

Mater Rusour, Res., Paper 491157.

1100 Runoff and etreamitou MARKOV FLOW MODELS AND THE FLOOD MARHING PROBLEM 5. Yakowicz (Systems and Industrial Engineering Depart-mont, University of Arizota, Tutson, Arizona, 8372)) 5. Yekewitz (Systems and Industrial Engineering Department, University of Arisons, Zuesen, Arisons, 83721)
Let (Y(1)) represent pariodically-marpled river discharge values. For sipolicity, say that a flood occurs at spech mel fif, for some fixed T. Yucilly. Assume that at spech m, the details maker most deried whether or not to issue a flood warning, this decision being based on the past floor record [1(1): [44]. Finally, assume that costs have been mesigned to the two types of mistakes; the "false mista" reent and the event that a flood occurs when no warning was insued. It is argued that emission the Gaussian assumption, standard time series methodology is inappropriate for the flood warning problem.
The purpose of this paper is its whiter recent progresses besed on situatusts principlem. A unopatement of inference procedure is described which converges to the optimal decision function for the flood varning problem as the length of the historical record increases, for secutially any vestionary ergodic harkov process. Dedar additional Assumptions, value cap be as rabilabed and shows to be compared with ABMA predictors on simulated and river flow data.

Water Resour . Rea. , Paper 491253

IIBO Water Quality
CONVERSION OF ARIZONA CHAPARRAL TO GRASS INCREASES
WATER VIELD AND NITRATE LOSS
E. A. Davis (Bocky Mountain Forest and Ranga Experiment
Station, Forest Service, UBDA, Arizona State
University, Tampe, Arizona, 85287)
Converting an Arizona chaparral watershed to grass
cover using a soil application of Arbutilists granules
increased streamiles and the mitrate content of the
water. Nitrate concentrations in streamflow from an
untreasted control watershed remained less than i ppm
throughout the study, whereas nitrate from the treated
watershed increased during the first posttrestmant year
to a maximum concentration of 56 ppm, with an annual
wateful dease concentration of 16 ppm, Maximum
concentrations of 60 and 69 ppm occurred during the
third and fourth posttrestmant years, when annual mean
concentrations were 56- and 100-fold shown normal.
After 11 years the annual mean concentration was still
la-fold shown tormal. The man nitrate concentration
of the streamics from the treated watershed for the
entire li-year peried was 29-fold greater then that for
the control watershed. (Chaparral conversion, water
yield increase, outrient loss).

Water Resour. Rec., Paper 491045.

Meteorology

3715 Chemical Composition and Chumical Interactions
PMOTOCHEMICALLY PRODUCED 020ME 1N THE EMISSION FROM
LARGE SCALE TROPICAL VEGETATION FIRES
A.C. Delany (Mational Center for Atmospharic Research
P.O. Box 3000, Boulder, CO 80307) P. Hasgenson, S.
Malters, A.F. Nartburg, and P.J. Crutzen
An affecreft measurement program was undertaken in the
savanna regions of central South America in the dry
sasan of 1980 to investigate the atmospheric effects of
large scale biomess burning. The scoke from the fires
was found to be largely confined within an approximately
sidence occurring during the atmospheric subpersists for week long partods due to the synoptic subpersists for week long partods due to the synoptic subpersists for week long partods due to the synoptic subpersists for week long partods due to the synoptic subpersists for week long partods due to the synoptic subpersists for week long partods due to the synoptic subpersists for week long partods due to the synoptic subpersists for week long partods due to the synoptic subpersists for week long partods due to the synoptic subpersists for week long partods due to the synoptic subpersists for week long partods due to the synoptic subpersists for week long central sazzil. The factors controlling the concentration of this ozona are
earnined and an estimate of the smount of ozona produced
is reported. (Ozona, tropical, biomass, fires).

J. Geophys. Res., D. Paper 401246.

J. Geophys. Res., D. Paper 401246.

J. Geophym. Res., D. Paper Abl246.

1713 Electrical Phenomena ANOSPHERIC-ELECTRICAL IMPLICATIONS OF 2228, DAUGHTER DEFOSITION OF VECTATED GROUND
J. G. Willett (Pavel Research Laboratory, Washington, D.C. 2075-5000)

Wateral diffusive deposition of radon daughter products from the stmoophers onto an serodynamically reegh, vegetated auriance may cause an important unbaucament of the innimation rate within the plant campy. For example, the blades of grass in a lewin may become elightly redionative, leading to higher ignization in the sir between them then above their tops. The impact of this increased ionization rate is unitessed from a simple model of the conductivity profils in the turbulent "slectred layer". It is found that an order-of-magnitude eigenenstion can have substantial effects on the slectrical structure. With this merivation, a non-disensional, steady state model of radop-daughter dry deposition is developed for abtimating the pagnitude of the deposited activity. The mineral scripts of the series of the surface acquaint and of the entire decay chain are included. This model predicts significant values and of the surface acquaint in the pagnitude of the deposited activity with the surface radioscrivity under the substantial only a surface radioscrivity under the substantial significant substantial substant

J. Gsophys: Res., D. Paper 4D1285. .

3745 Gravity Maves, Tides, and Compressional Haves
AN OBSERVATIONAL ESTIMATE OF GRAVITY MAVE DRAG FROM THE
MOMENTUM BALANCE IN THE MIDDLE AIMDSPHERE
Anne K. Smith (National Center for Atmospheric Research*,
P. O. Boa JOO, Boulder, Colorado 80307), Lawrence V. Lylat
The Zonal average momentum budget in the middle atmosphere (up to C.) mb) is computed for seven months of
satellite observations in order to determine the forcing
needed to obtain a balanca. This momentum residual includes
forcing by maves with small zonal scales such as gravity
waves. The results indicate that the forcing needed in
the lower mesosphere reaches poak values of about 20 m s
day!, which is large compared to the Rayleigh friction
used in that part of the atmosphere in numerical models
such as that of Holton and Webrboin (1990a). The seasonal
change follows that of Rayleigh friction; the Northern
Hamisphere momentum deficit is large easterly in winter,
decreases in the spring and bocomes small westerly in late
spring. However, the largest momentum deficits are in
middle and high latitudes (50°-80°N). In winter, whereas
the largest Rayleigh frictional damping is in the vicinity
of the jet (30°-30°N).
The observations were also compared with the parametarized
acceleration of the moan flow by gravity waves (Lindzon,
1981; Holton, 1983). The observations of the wintertime
momentum residual are similar to the values used in the
circulation model of Holton (1983). Derivation of the
parameterization constant from the setellite observations
results in an equivalent zonal wavenumber for gravity
waves that is substantially smaller than that used by
Holton (1983) in his model. Possible reasons for this
difference are that many of the gravity waves break at
levels above the region where dat are available, and that
gravity waves with non-zero phase speeds may be present.

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d Box 1006, Bertmouth, M. S., Canada, 827 842 to a series of necessreposts of Co2 (Low over the sea the mean flux was near sero even though the surface water had substantially higher partial pressure of CO2 than the air. Hourly variation in wind speed were well correlated with the flux, suggesting that a wind-driven process such as wave breaking and downward mixing of bubbles may drive additional CO2 into the water as the wind speed increases. The traditional model of elf-sea 2ss flux as a function of sea-sir partial pressure difference was modified to include downward pumping by wind. We conclude that the flux of nonstmooblets model for the two-way surface flux of

J. Geophys. Res., C, Paper 4C1277.

4713 (Circulation)
THE SINULATED RESPONSE OF AN UPPER-OCEAN
DENSITY FRONT TO LOCAL ATMOSPHERIC FORCING
David Adamsc (Department of Meteorology, Naval
Postgraduate School, Monterey, CA. 93943) and
R.M. Carwood Jr. (Department of Oceanography,
Naval Postgraduate School, Monterey, CA. 93941)
Four numerical experiments with different
to Naval Postgraduate School, Monterey the different Four numerical experiments with different atmospheric forcing are considered to investigate a variaty of transient responses of an upper-vicial density front similar to the Maltese front (south of Sicily) in an embedded Maltese front (south of Sicily) in an embedded

mixed layer - ocean circulation model. Of particular interest is a case that simulates forcing observed by Johannessen (1975): In May 1971, measurements of the Moltene front were being taken in calam weather and then the wind suddenly increased to 10-15 m/s down the front. For this forcing, the model result is consistent with the observations predicting steepening of the frontal interface, appreading of the surface inopyrnals and very little horizontal displacement of the surface front. However, the model predicts too much mixed-layer deepening and fails to predict the observed strangthening of the slong-front flow. Three additional experiments are considered to assess the effects of a change in the wind direction and the inclusion of a durnal surface buoyancy flux. The inclusion of a durnal surface buoyancy flux: when the surface buoyancy flux is negative, the mixed layer reforms at a shallow depth, resulting in much higher advecting velocities and subsequently larger displacements of the surface front. The negative buoyancy flux can effectively protect the surface layer; it also decouples the deeper frontal processes from the surface mixed-layer processes. [Numerical model, atmospheric forcing, mixed layer).

J. Geophys. Res., A, Paper 448140.

Particles and Fields— Ionosphere

5343 Ionospheric disturbances
A LABORATORY INVESTIGATION OF THE HIGH-PREQUENCY
FARLEY-BURELAN INSTABLISTY
B. Kustoms (Dept. of Physics and Astronomy, University
of Iosa, Iowa City, Iowa 522,23, N. D'Angelo and
R. L. Marlino
A laboratory investigation of the high-frequency
Farley-Bumenan instability is described. The instability was studied theoretically by Ios et al. [1971]
and is predicted to occur in the lose Englon of the
locosphere when the E/B drift velocity of the uladtrona
relative to the loss is several Lines Cg., the lonacoustic speud. In our experiments, an increase of the relative to the tone is several these C_{g} , the tonacoustic spead. In our experiments, an increase of the
electric field will above the fee et al. "threshold"
marely enhanced the general power level of the fluctuations but does not affect approciably their spectral
shape. The observed frequency spectra fall off very
repidly with increasing frequency, with a spectral
shape of the type $\Pi(f) \circ f^{-1}$. This room has nonive implications for a recently proposed mechanism of
"amonalous" may a electron beating in the lower E region
of the ionosphere. (Ionospheric disturbances, Farleyhumean instability).

J. Geophys. Res., A. Paper 4A8095.

EXPERIMENTAL RESULTS FROM THE "HERO" PROJECT: IN SITE NEASUREMENTS OF IONOSCHERIC MODIFICATIONS USING SOUNDING RASHEMENTS OF TOROGINERIC MODIFICATION: USING SUBMINING ROCKETS

G. Rose (May-Planck-Inutitut für Aeronomie, D-Mil Battenburg-Lindau, F. R. Muymany), G. Orandel, K. Meske, W. Ctt, K. Spenner, J. Helter, L. Månaide, J. Treitm During the KRating Rocket project HEMO four Instrumented payleade were launched on mounding rockets from Anddyn Rocket Hange in autumn 1992 to measure in attuche modifications at Y-Inyor heights set up by the Hanting facility at Runfjord near Tremming in Morthern Marsey. Coherent spentra of the Jelectric field components of the Innally generated victima plasma waves were obtained in a bookin with band many the reflection joyal of in healting wave and the majitude and phann of the Jeogramonia of the innally may may be in alactric and simultaneously. At the man than the iom-neousle frageency range was somitured and quanti-continuous measurements were associated on involving fraguency uning linear dipole antanona. Meronor, manauranents were need of incomposity of the leating fraguency uning linear dipole antanona. Meronor, manauranents were need of electron temperature, superitared unit fraguency uning linear dipole antanona. Meronor, manauranents were need of electron temperature, superitared incomposity fraguency within the Lecand time intervals when the Henting villancian danting any patents, by large amplitude variations and by no occ-to-one correlation with the Heating wave applitude.

J. Geophys. Ros., A. Papor 4A8244.

Particles and Fields-Magnetosphere

U. S. Lean (Space, This communications and Badionicese Lab, Stanford University, Stanford, California 194306, T. F. Bell

Spectrally broadward VLF transmitter signals are observed on the DEtainline using alternatively but elactic and magnetic field seasors. It is
band-with requestion when the electric field component bands band-with requestions (up to ~ 110 IIs) the magnetic field component has
band-with requestions (up to ~ 110 IIs) the magnetic field component has
band-with requestions (up to ~ 110 IIs) the magnetic field component has
band-with requestions of the local field when the second of the broadward of the
docate C and B-field magnitudes of the broadward signals are used to deready a sudvanced without smoking any strong amplification process that opsearce in conjunction with the appetral broadward, or the implications of this
broadward are discussed. (Satellite observations, spectral broadward, Itaninited against a second without smoking any strong amplification process that opsearce in conjunction with the appetral broadward of the process that opleading in distinguishing among the various possible mechanism for spectral
broadward are discussed. (Satellite observations, spectral broadward, Itaninited against the spectral broadward or spectral
broadward.

J. Caphys. Res., A. Paper 4AS277.

Planetology

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RECTRAL ANALYSIS OF GROOVE SPACING ON GANYMEDE

L.E. Grimm (Dept. of Earth, Atmospheric, and Pienetary

RCL), MIT, Combridge, NA G2139), S.W. Suyres

Geoven on Canymade are interpreted as excessional

Lottopic features whose regular specing is on Indicator

sphere, at the time of deformation. We have performed a

statistical smallysis of groove spacing do Canymade,

statistical smallysis of groove spacing do Canymade,

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power spacers for peaks representing the dominant: Copo
fraphic, periodicities, the distribution of groove

a minimum of 3.5 hm, 'a maximum of 1.7 km, and a mean of

stitude or longitude. The most spating fracture of the

geographic distribution is that, while graove spacing with

tands to be quite constant within a given groove set, it can vary substantially from one groove set to another in a geographic region, An exception to the first standard variety of the season groove set to another in a geographic region, An exception to the Universal variety of 6.3 km and very little warlability. He exemine several models that rolate the observed groove spacing to lithospheric thicknesses. The most theorems conclusion is that it hospheric thicknesses. The most theorems against femally from one was examine four possible causes for the heterogeneous distribution; variation in the of formatice during a parted in which the global mann hest flow was changing, variation in strait rate from one groove set to the variation in strait rate from one groove set to the variation in the vigor of underlying convective upwallings, and local excursions in geothermal gradient caused by verifications in the vigor of underlying convective upwallings, and local excursions in geothermal gradient viable, while the fourth requires very tapid groove formation due to the short cooling times involved.

J. Geophys, Res. B. Penne absence.

J. Geophys. Res., B, Paper 4B5060.

Tectonophysics

Write:

8199 General Tectonophysica
DISPLACEMENT AND STRAIN PATTERNS OF EXTENSIONAL OPOCENS
Foy Kilgiteld and Jean Crespi (Dept. of Coological
Sciences; University of Colorado; Boulder, CO 80309);
3. Naruh and G. H. Davis (Dept. of Genericences;
University of Arizons; Tuceon, AZ 85021)
Rock fabrics that result from displacement in
satemational orogens provide a means of identifying
geometric codels responsible for matemation of
continental crust. Strain compatibility argumente
indicate that a finite estemation can be accomposed by
displacements across (1) planar, noarotating (switz or
ductile shear zones, (2) when xones which rolets shows
a horizontal detachment (the domino model), or (3)
shear somen which rotate as a result of a horizontally
oriented, pura shear stretching coopenent (the plastic
godel). Limite, normal shear zone gwocelries may
develop as the result of a depth dependant change in
the pure shear component (in the plastic model) or the
stretching coopenent (in the planar shear zone model).
Within the geometric framework of these various models,
the effects of superposed slepts shear, pure shear
extunyion, and sten change on the tock fabric are
investigated. These displacement components, which cap
be superposed sequentially or simultaneously, determine
the state of finite strain associated with a given
magnitude of tectonic extension. The relationships
between displacement and strain are expressed as graphs
of foliation dip (or strain vario) versus shear strain
and as graphs of foliation dip (or strain ratio) versus shear strain
and as graphs of foliation dip (or strain ratio) versus shear strain
and as graphs of foliation dip (or strain ratio) versus shear strain
and as graphs of foliation dip (or strain ratio) versus shear
the effects of the different displacement components up
the rock fabric in a single shear zone, whereas the
effects on the regions scale. The shear strain and
tectonic extension graphs batter fillustrates these
effects on the regions scale. The shear strain and
tectonic extension gra areas in metamorphic core complexes of Arisons and in the Basin and Range province of the North America Conditions. (Tectonics, strain, continental rifting).

Volcanology

Toctonics, Paper 470968.

-8699 Volconology
THE MAY 18, 1980 ERUPTION OF NOUNT ST. BYLENS II.
MODELLING OF DYNAMICE OF PLINIAN PEARS?

3. H. Carey and H. Sigurdason (Grad. School of Oceano-graphy, University of Rhods Island, Narragamaett, E.I.,
02882).
The plinian phase of the May 18, 1980 Mt. St. Baleon
oruption is modelled as a standy-state discharge of
dealtic magna from a reservoir at 7 to 10 km dapth at s
rate of 1.92x10³kg/s. Properties of the magna, including
pre-eruption volatile content (4.6% in the molt), temperature (920-940°C), and confining pressure (190-250 MPs)
are constrained by petrologic studies. Mass sraption
rate, magna viscosity and independent estimates of sagna
ascent velocity suggest a 93 pater diameter conduit at a
dopth below wayor saturation. Dispersal of pyrochasta
indicate a minimum emit velocity of roughly 200 m/s
during the pilnian phase. An upper limit of 310 m/s is
obtained from the total magnat of amolyed volatiles.
Model-derived want diameter's based on 0, 1 MPs actipressure, petrologically-infersal esgma properties and pressure, petrologically-inferred magas properties and known mass eruption rate, range from 105 to 135 merers with a flared configuration. The calculated vent diameter, mass eruption rate and exit velocity define 486 Greens (Planum instabution)
SPECTRAL BROADENING OF VLF TRANSBUTTER SIGNALS OBSERVED
U I have a QUASI-LECTROSTATIO PHENOAGENONT

9280 Pacific Coses
MEAR EQUATORIAL CTO DESERVATIONS AP 85°M IN OCTORER 1982
J. N. Tools (Woods Bole Oceanographic Institution, Woods
Bols NA 02543)
CTO data collected about the equator along 85°M between
8 and 12 October 1982 are used to investigate stratification changes in the upper I as suscotated with the
1982/83 XI Mido. With raspect to the thatsal field observed in November 1981, virtually the unites sentions
swhibited domorand displanements in the upper Made Relatively symmetric shout the equator. This stratification things
of the mean thermolible ware large, wilson, and calatively symmetric shout the equator. Displacements at the depth
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G. S.

Global Compressional Oscillations of the Terrestial Magnetesphere: The Bridence and a Model
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Relati

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accepted

a variational principle and malerkin fortulation are combined with the finite-stement cotted to develop a new technique to investigate coupled thereal bydraville-machanical behavior of liquid-saturated, tractured pyrous rocks. A distributed to the decided as performed, famally, the environment of a heater copia of in hard rock is smallated. The effects of the coupled thermal strasses in the itaxtured that it is maintained that are reduction of permeability due to the delicitation of the fractures. These results can improve the understanding of observations and displacement resource means made in the insitu experiences at the Stripe mine in Swaden. (Coupled Phenomena, fracture flow, theree-elestic consolidation).

or outside contiguous USA)

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Journal of Geophysical Research

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